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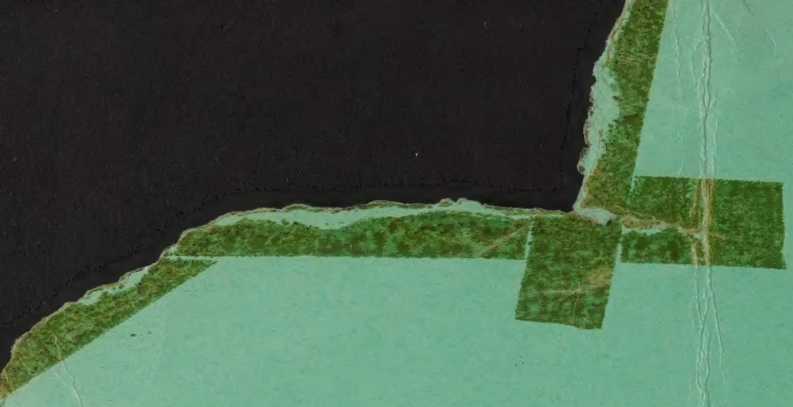
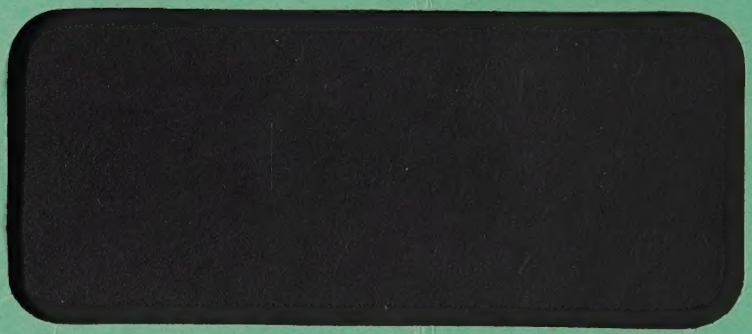

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AUTOBALANCE COMPONENT BRIDGE

B421

INSTRUCTION MANUAL

SER Nº 367

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AUTOBALANCE COMPONENT BRIDGE B421

INTRODUCTION

The Autobalance Component Bridge B421 is a direct-reading instrument for the rapid determination of resistance, capacitance and inductance values. A comparator facility allows any component to be compared with an external standard, a separate meter scale, calibrated from -25% through zero to +25%, being provided for the purpose.

The instrument is transistorized, uses printed circuit techniques and operates on the transformer ratio arm principle. Since the bridge is self-balancing, both for in-phase and quadrature components, its use is very simple, the controls being limited to those necessary for initial calibration, range and facility selection and a single decade control. The latter operates on the C and R ranges only and is used when the required accuracy is greater than that given by the basic meter indication . The pressing of a button converts the meter indication to series resistance of inductors or parallel resistance of capacitors as the case may be. The marking of both the meter scale and the range switch is simplified by the inclusion of a colour-coded plate on the front panel. This plate shows in tabulated form the meter multiplication factor for each range and facility. A separate table gives the coverage of the comparator bridge ranges.

A feature of the B421 is its ability to measure high value electrolytic capacitors and their leakage currents. Normal bridge principles are not suitable for measuring these components and, moreover, since their tolerance is usually about -10 to +100% of nominal value, a measuring accuracy of one-quarter per cent is meaningless. The B421 therefore has a special circuit for measuring capacitance values above 10μF.

Screened connectors are provided for the two coaxial measurement leads, each terminated in a single crocodile clip. These provide the two connections to the component under test.

The instrument is 'splash-proof' and meets full Government climatic and durability requirements which, in conjunction with its portability, makes it eminently suitable for use in the field. If desired, the mains operated power supply PS109/2 can be removed and the instrument can then be connected to an external battery supply.

SPECIFICATION

Measurement Ranges

Range	Resistance R	Inductance L	Series Res. R_S	Capacitance C	Parallel Res. R_p ‡
1	0 - 10Ω	0 - 100μH	0 - 1Ω	0 - 10μF	100Ω - ∞
2	0 - 100Ω	0 - 1mH	0 - 10Ω	0 - 1μF	1kΩ - ∞
3	0 - 1kΩ	0 - 10mH	0 - 100Ω	0 - 100nF	10kΩ - ∞
4	0 - 10kΩ	0 - 100mH	0 - 1kΩ	0 - 10nF	100kΩ - ∞
5	0 - 100kΩ	0 - 1H	0 - 10kΩ	0 - 1nF	1MΩ - ∞
6	0 - 1MΩ	0 - 10H	0 - 100kΩ	0 - 100pF	10MΩ - ∞
7	0 - 10MΩ	0 - 100H	0 - 1MΩ	0 - 10pF	100MΩ - ∞
Accuracy	±0·25% of Range max.	± 2% f. s. d.	± 2% f. s. d.	±0·25% of Range max. §	± 2% of Range min.
Indication	Decade Dial and Meter	Meter only	Meter only	Decade Dial and Meter	Meter only
Discrimination	0·1% of Range max.	1% f. s. d.	1% f. s. d.	0·1% of Range max. ‡	-
Smallest Indication	20mΩ §	2μH *	20mΩ *	0·02pF §	110Ω §

* If it is required to measure inductance in which the series resistance is very great, the smallest indication can be regarded as 2μH per ohm f. s. d. Conversely, if it is required to measure resistance in the presence of swamping inductance, the smallest indication can be regarded as 200Ω per Henry f. s. d. This is equivalent to a Q of approximately 30.

‡ The resistance (R_p) ranges quoted in the table above apply when the decade dial is in use. When the decade dial is set to OUT the resistance range is decreased by a factor of 10. Thus, for example, on Range 7 with the decade OUT the meter indicates 0 - 10pF and the corresponding parallel resistance range is 10MΩ - ∞. The capacitance accuracy with the decade OUT drops to 2% f. s. d. and the discrimination to 1% f. s. d.

§ With Decade switch in circuit.

High Capacitance (Ce)

Range	Scale Range	Applied Voltage	Leakage Current ⋕
1	-	-	0 - 10mA
2	-	-	0 - 1mA
3	-	-	0 - 100μA
4	10μF - ∞	20/C volts §	-
5	100μF - ∞	200/C volts §	-
6	1000μF - ∞	2000/C volts §	-

§ C is the value of the measured capacitance (μF).

⋕ Measured with 3V applied. Leakage current is independent of capacitance value.

Indication by meter only on green reciprocal scale.

Largest indicated value: 50, 000μF.

Accuracy: (4 + A) % where A is the scale indication.

Comparator

Range of comparison: ±25% indicated on blue centre-zero scale of meter.

Accuracy: ±1 scale division

Discrimination: 0·5 scale division

Comparator Range Coverage

Range A: 1Ω to 200kΩ, 2mH to 20H, 1nF to 10μF
Range B: 50kΩ to 10MΩ, 5H to 1000H, 10pF to 4nF

Bridge Frequency 1000c/s ± 2%

Operating Temperature 0 - 55°C

At the extremes of the working temperature range the accuracy of the instrument deteriorates by a maximum factor of two (three on electrolytic [Ce] measurements).

Temperature Coefficient of Standards

R: 20 p. p. m. per deg. C
C: 15 p. p. m. per deg. C

Power Supply

The instrument is normally supplied fitted with Power Supply type PS109/2 for operation from 100 - 125V or 200 - 250V, 50 - 60c/s. However, this unit can be withdrawn, thus exposing a pair of leads which can be connected to an external 9V dry battery (e. g. two E. R. type 126 batteries) if it is required to operate the instrument in the absence of a mains supply.

Current drain: approximately 30mA on R and L
25mA on other facilities

Dimensions

Height:	9 in. (23 cm.)
Width:	11 in. (28 cm.)
Depth:	7 in. (18 cm.)
Weight:	12 lb. (5·5 kg.) approx.

Ancillary Equipment Supplied

Two pairs of connectors terminated at one with BNC connectors and at the other end with crocodile clips.

OPERATING INSTRUCTIONS

Preliminary Checks

When the instrument is powered with dry batteries, set the Facility switch to the check battery position (marked ⊣⊢) and note that the meter indication is above the MIN. BAT. VOLTS line. If this is not the case, renew the batteries. This check is not necessary when power supply unit PS109/2 is fitted except as a power check in the event of non-operation of the instrument. The power transformer connections are as follows:

200 - 250V operation	terminals 2 and 3 linked	
100 - 125V operation	terminals 1 and 2	linked
	3 and 4	linked

If the L, C or R facility is to be used, set the Facility switch to the appropriate position and the Calibrate switch to F. S. D. (L. C. R.). Adjust the right-hand calibrate control until the meter indicates 10.

If the Ce facility is to be used, set the Facility switch to Ce and the Calibrate switch to Zero (Ce). Adjust the left-hand calibrate control until the meter indicates ∞ on the green reciprocal scale.

Set the Calibrate switch to Operate.

Inductance Measurements

Connect the component under test directly to the Unknown sockets. Set the Facility switch to L and the Range switch to 7. Decrease the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the unknown inductance.

The series resistance of the inductor under test is obtained by pressing the white button situated to the left of the range numbers beneath the meter. The appropriate multiplication factor from the table must be applied to the meter indication (black scale) to obtain the value of the series resistance.

Example: The meter indicates 2·5 when range 4 is selected.
The L multiplication factor for range 4 is 10mH and so the inductance of the component under test is 25mH.
On pressing the white button, the meter indicates 1·4.
The Rs multiplication factor for range 4 is 100Ω and so the series resistance is 140Ω.

NOTE: If the meter deflection is off the scale when the white button is pressed (i. e. the Q is less than unity at 1kc/s) turn the range control to the next higher range and check the inductance value on this range before measuring the series resistance. This is necessary because the inductance measurement is valid only if the series resistance indication is on scale for the range in use. FOR THIS REASON Rs SHOULD ALWAYS BE MEASURED WHETHER THE INFORMATION IS REQUIRED OR NOT.

Capacitance Measurements

Refer to Preliminary Checks on page 5.

Connect the component under test directly to the Unknown sockets. Set the Facility switch to C, the Decade switch to OUT and the Range switch to 1. Increase the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the unknown capacitor. The value thus obtained is accurate to within ±2%. For greater accuracy, transfer the first digit of the meter indication to the Decade switch; the meter indication is then the second and subsequent significant figures of the required value.

The parallel resistance of the capacitor under test is obtained by pressing the white button to the left of the range numbers beneath the meter. Note the meter indication on the GREEN reciprocal scale and apply the appropriate multiplication factor from the table to obtain the value of the parallel resistance. Note that the multiplication factor as read from the table applies only when the Decade switch is in use. When the Decade switch is set to OUT, the multiplication factor for Rp must be divided by 10. Thus the parallel resistance of capacitors having a poor power factor can be measured with the Decade out.

Example: The meter indicates 4·6 when range 5 is selected. The C multiplication factor for range 5 is 100pF and so the capacitance of the component under test is 460pF. If, when the Decade switch is set to 4, the meter indicates 6·8 the correct value of the capacitor is 468pF. In this condition, on pressing the white button, the meter indicates 2·5 on the green reciprocal scale. The Rp multiplication factor for range 5 is 1MΩ i. e., 1 on the green scale is equivalent to 1MΩ and so the parallel resistance of the capacitor is 2·5MΩ. Had the white button been pressed before the operation of the Decade switch, the meter indication would have been approximately 25; the Rp multiplication factor then being one-tenth that shown in the table (i. e. 100kΩ) gives a parallel resistance of 2·5MΩ as before.

NOTE: As with inductance measurements, the capacitance indication is valid only if the associated parallel resistance measurement is 'on scale'. If the meter deflection is off scale (i. e. less than 1 on the green scale) when the white button is pressed, move the Range switch to the next lower number and repeat the capacitance measurement.

Resistance Measurements

Refer to Preliminary Checks on page 5.

Connect the component under test directly to the Unknown sockets. Set the Facility switch to R, the Decade switch to OUT and the Range switch to 7. Decrease the measurement range until a meter indication between 1 and 10 is obtained on the black scale. From the table beneath the meter, note the multiplication factor for the appropriate range and apply this to the meter indication to obtain the value of the Unknown resistance. The value thus obtained is accurate to within ±2%. For greater accuracy, transfer the first digit of the meter indication to the Decade switch; the meter indication is then the second and subsequent significant figures of the required value.

Example: The meter indicates 4 when the Range switch is set to Range 3. The R multiplication factor for range 3 is 1kΩ and so the value of the resistor is 4kΩ. If, when the Decade switch is set to 4, the meter indication falls to -0·2 (in the red sector to the left of the black scale) the correct value of the resistor is 3·98kΩ. This can be verified by resetting the Decade switch to 3, whereupon the meter indication should rise to 9·8.

Electrolytic Capacitance and Leakage Current Measurements

Refer to the Preliminary Checks on page 5.

Set the Facility switch to Ce and the Range switch to 4. Connect the component under test to the Unknown sockets, positive of the capacitor to the E socket.

Press the black button at the lower right-hand corner of the table on the front panel and check that the meter indicates ∞ on the green scale. Release the button. When the meter has slowly deflected and come to rest, note the meter indication on the green scale (this should not go beyond 1 or go beyond the final rest position and then return, on the range chosen, because this indicates an overload condition). If the meter indication is between 10 and ∞, select range 5 and repeat the foregoing operation; if the indication is still between 10 and ∞, select range 6 and again repeat the operation. Note the final meter indication and apply the appropriate multiplication factor from the table beneath the meter to obtain the value of the capacitor under test.

To measure the leakage current, set the Range switch to 1 and allow a few seconds for the capacitor to charge. Press the black push button and note the meter indication on the black scale. If the indication is less than 1, change the Range switch setting to 2 or 3, as necessary, while holding the black button pressed. Apply the appropriate multiplication factor to the meter indication to obtain the value of the leakage current for the capacitor under test.

The Comparator

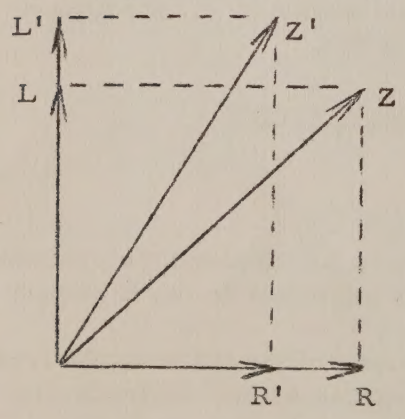
Refer to the Preliminary Checks on page 5.

If the components to be compared are resistive or inductive, the reference component should be connected to the Standard sockets; if the components are capacitive, the reference component should be connected to the Unknown sockets.

From a knowledge of the nominal value of the components, select Comparator Range A or B as appropriate. The meter then indicates on the blue scale the percentage difference between the values of the components.

An indication of +x % means that the value of the component connected to the Unknown sockets is greater than that of the component connected to the Standard sockets by x %.

Note: The Comparator compares the impedance of the unknown and reference components. Due regard should be given to this fact when comparing components having an appreciable angle (i. e. low Q or high power factor). The exaggerated condition shown in the diagram inset clarifies the meaning. The Comparator bridge would indicate that the two inductors were of equal impedance.



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